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of which would vow to devote themselves to the cause of truth, to deal justly and courteously with one another and with all laborers for that cause and to keep the scientific record purged of what is false or mean.

Not to dwell further on this subject, I will now briefly emphasize the central points of this address:

The first is that absolute truth is not knowable, and that even to the end of time it will be so.

The unfinished window in Aladdin's Tower
Unfinished must remain.

The second point is that scientific truth of any age is that which works and consequently it may change and present a new aspect with each succeeding generation.

The third is that the scientific spirit is, when rigorously exercised, the only test of what works or what is scientific truth.

The last point is that science is not and never can be infallible, and we should be thankful for that, for, if it assumed infallibility, the progress of the human mind on the path of truth would cease.

Before I conclude finally I would call attention to a rendition of the ideal scientific spirit which is to be found in a passage of Tennyson's "Ulysses." The old hero is there represented as having, after ten long years before the walls of Troy and ten more years of peril and adventure on the sea, returned to Ithaca, his old home, and as now resolving to take up the life of change and discovery even though the gulfs should wash him down. The passage which I quote should be indelibly fixed in the memory of every scientific worker:

I am a part of all that I have met;
Yet all experience is an arch wherethro'
Gleams that untravell'd world whose margin fades
Forever and forever when I move.
How dull it were to pause, to make an end,
To rust unburnish'd, not to shine in use!

As tho' to breathe were life! Life piled on life
Were all too little, and of one to me
Little remains, but every hour is saved
From that eternal silence, something more,
A bringer of new things, and vile it were
For some three suns to store and hoard myself,
And this gray spirit yearning in desire
To follow knowledge, like a sinking star,
Beyond the utmost bound of human thought.

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EUGENE WOLDEMAR HILGARD, A BIOGRAPHICAL SKETCH

EUGENE WOLDEMAR HILGARD was born January 5, 1833, at Zweibruecken, in Rhenish Bavaria, the son of Theodore Erasmus and Margarethe Hilgard, and was the youngest of a family of four sons and five daughters. His father was a lawyer, holding the position of chief justice of the court of appeals of the province. Judge Hilgard, having been born and educated under the shadow of the French Revolution, and being of pronounced liberal views, stoutly opposed the supersedence of the code Napoleon by the illiberal laws of the old régime. In 1836, when at the fullness of a successful career, he determined to emigrate to America with his family and settled on a farm at Belleville, Illinois. As the public schools of that day were quite primitive, Judge Hilgard personally undertook the preparation of his sons for entrance to the universities. Eugene was in readiness in 1849 and in that year returned to Germany to attend the University of Heidelberg, graduating with honors and a doctor's degree with *summa cum laude* in 1853. This degree was re-issued to him in 1903 as a "golden degree" in recognition of half a century's good work for science. He studied also in Zurich and Freiberg, in Saxony. After graduating in 1853 he visited Spain and met Miss J. Alexandrina Bello, daughter of Colonel Bello, of the Spanish army, whom he married several years later. Returning to America, he began geological exploration work in Mississippi in 1855 and was appointed state mineralogist of that state in 1858. In 1860 he revisited Spain, married

Miss Bello and resumed his work in Mississippi in November of that year. During the intervention of the Civil War he pursued the chemical work required by the Southern Confederacy. In 1866 he was chosen professor of chemistry in the University of Mississippi, and later professor of geology, zoology and botany. In 1872 he left Mississippi to take a position on the faculty of the University of Michigan, but remained there only two years, when he was called by the regents of the University of California to California in 1874. While developing agricultural instruction in the university, he proceeded with research work immediately after his arrival in California and published his first results in 1877. His work in the investigation of soils in connection with their native vegetation, of the influence of climate on the formation of soils and especially of the nature of "alkali soils" and their reclamation, a problem quite new not only in this country but in other arid regions, achieved for him a reputation as wide as the world of science. It brought him recognition on numerous occasions. Mississippi, Columbia and Michigan universities, as well as the University of California, have bestowed the Doctor of Laws degree upon him. The Academy of Sciences of Munich presented him with the Liebig medal for distinguished achievements in the agricultural sciences and the international exposition at Paris, in 1900, gave him a gold medal as a collaborator in the same research.

Soon after coming to California he directed the agricultural division of the northern transcontinental survey. From 1879 to 1883, in connection with his university work, he assumed charge of the cotton investigation of the census of 1880 which he projected and carried out on a broader plan than ever before undertaken. During the whole period of his academic career Professor Hilgard was constantly active in authorship. In addition to formal reports and memoirs, he wrote much for agricultural and scientific periodicals. His greatest book is "Soils of Arid and Humid Regions." The simple form of this work is "Agriculture for Schools of the Pacific Slope,"

undertaken in collaboration with Professor W. J. V. Osterhout, formerly of the University of California.

In 1892 he revisited Europe and was received with distinguished honor by his colleagues in science in the German universities and experiment stations, and by invitations to deliver public addresses on the subjects in which he had made the chief achievements.

Since 1910 Professor Hilgard's advanced age rendered him unequal to the pursuit of extensive tasks. He maintained, however, his membership in several scientific societies and was vitally interested to the last in investigations connected with his science.

The greater part of Hilgard's career was spent at the University of California. Of the many and various problems which he faced at the beginning of his work there, three seem at this moment to give best clue to the masterfulness of the man and fullest understanding of the breadth and depth of his success:

First: the conciliation and conquest of his farming constituency, by demonstration of practical and indispensable value in the work he could do.

Second: the enforcement of recognition of agricultural studies as entitled to the dignity of higher learning and as possessed of pedagogic value.

Third: the securing of funds to pursue research which could alone yield truth about natural conditions affecting California farming, and to increase his working force, without which he could neither get the truth nor teach it in its several branches and applications.

I clearly recall an early instance of Hilgard's method. I was present at a farmers' meeting in San Francisco in 1876, apparently called to see just how far the college of agriculture at the University of California had fallen. The room was not large and was crowded with men of some prominence in farming and hostile to the university because they really believed that the college of agriculture ought to be snatched from ruinous association with a so-called "classical institution." It was a stormy assembly, but when

there came a lull the chairman asked Hilgard to speak. He rose alertly, showing them a slim, graceful figure, and when he had folded and pocketed the blue glasses which a long-continued eye trouble forced him to wear, they saw a scholarly face illumined with an eagerness, cordiality and brightness of expression which seemed to say to them: I never was in such a delightful place before in my life. Before he could say a word he had them transfixed with surprise and curiosity, and when he began to speak in a low, conversational voice, with an accent which compelled them to listen closely, every man was at attention. He was saying that he was glad to meet them; that no one could do much for farming unless he had personal knowledge and support of farmers; that he had listened with interest to what they had been saying and much of it doubtless would be helpful to him; that other things they could talk over and agree upon when they became better acquainted; that he had come to California to try, with their help and support, to know California, from the rocks to the sky, and proposed to use all that he had learned in other lands merely as a help to begin to know California, which he already perceived was different from any other land in which he had lived and worked. He wished to work from California outward, not to try to fit old theories to a new state. He had always been interested in differences and wanted to see what they were and how they worked in farming. On his father's farm in Illinois he learned that the soil was not all alike and he had been told that soil differed when it came from different rocks, when it was moved about in different ways, and when other things were mixed with it, and that since boyhood he had been studying the rocks, the soils, the plants, to see what was in the soil and in the plant in the hope of matching them up to get the best crops and the most money in farming. Then followed a charming half-hour with soil formation and movement, tillage, fertilization, etc., without a scientific term, without reference to a chemical formula, all straight farming talk about soils and plants. Finally he said he had come to find out how these things worked in California.

Within a few years Hilgard was able to render his first great service to the community in which he lived by promoting a sympathetic understanding between the farmers of the state and scientific learning, so that the college of agriculture became firmly established as a part of the state university by constitutional amendment. The influence of this achievement was wide-reaching, for it has proven a rock upon which efforts for dismemberment of land-grant universities in other states have been dashed to pieces.

Hilgard's scholarly preparation was wide. Aside from scientific branches, he knew his Latin and his Greek and the literatures of them, and only the distinguished professor of German of that day could surpass him in conversational scope in modern languages. And he loved all this learning and constantly used it familiarly, while, beyond all conscious employment of it, there it was forming his thought, gracing his style and in every way influencing his action and enriching his life.

He was thus able ultimately to command the interest and respect of both the scientific and classical portions of the university community in his service to the state. He was always broader than his own science. He was a real man and a true philosopher.

Hilgard's work was permanently successful because with clear vision he founded it upon principles the soundness of which has since been demonstrated and generally recognized. In his first report, published in 1877 he said:

A knowledge of facts and principles and not the achievement of manual dexterity, must be the leading object of a truly useful course of instruction in agriculture. . . . Object teaching should be made the preeminent method of instruction in natural, and more especially in technical science. Manual exercise should be made the adjunct of the instruction in principles.

Thus Hilgard announced at the very beginning his adoption of the laboratory and field method of instruction and he pursued it so far as he could command the outfit for it.

That the structure of Hilgard's achievements in the University of California was his own from the ground up, appears from another extract from his first report.

The appropriation of \$250 for the beginning of an experiment station has, under advice, been carefully husbanded by me after the failure of the appropriations asked of the last legislature, in order to insure the continuation of the home work.

Fortunately the legislature of 1877 gave him \$5,000 for two years and the legislature of 1879 gave \$5,000 a year for two years, of which he says, in his report for 1880, "it barely enables us to pay running expenses, and farther improvement and increase of scope will be impossible"; for he then had half a dozen field and laboratory assistants to provide for. At the same time, however, that his local patrons and employers were wondering how Hilgard could use \$2,500 for expense money, the United States gave him not less than \$25,000 to spend in his cotton work.

The stand taken by Hilgard with reference to the dignity and pedagogical value of agricultural science, while so many institutions, now great, were in their formative periods, was recognized as sound throughout this country and beyond. Set forth in his early reports, it exercised a profound influence. The proper relation of agricultural practise to agricultural science, as factors in educational effort; the educational distinction between labor performed for enlightenment and labor prescribed to beget a liking for labor; the place of both the art and science of agriculture in a university of higher learning, when both are handled ably for instructional purpose—these were among his fundamental contentions, upholding them through many controversies, and his victory is seen in their entry into the regular curricula of all of the newer institutions of learning and their pursuit by older institutions established upon other standards of learning before the existence of these educational factors was dreamed of as worthy and capable.

Hilgard's strategic diversion of 1879 to 1883 was one of the brightest and most effective movements of his career. On the basis of his work in Mississippi he was requested by the director of the census of 1880 to take full charge of the cotton investigations for that census and to do something greater for the

cotton industry than was ever done before and he was promised funds for inquiry, investigation, laboratory work and whatever else he deemed necessary to get at the fundamental facts and principles connected with cotton growing in the United States. He reviewed the subject as a whole and in divisions, studied each cotton state and finally, after four years of work, produced in two volumes his report upon the cotton industry of the United States, a lasting benefit to all cotton-producing states. This report, in two quarto volumes, was a force in engraving original research upon the instructional work, established through the educational land-grant law of Morrill, by the enactment of the Hatch law for state experiment stations in all states.

The results of Hilgard's labors are in the warp of California's first half-century of intellectual and industrial life. He was quick to see his opportunities for public service, to recognize his duty therein and he was masterful and tireless in pursuit of it. He was bold in conquest of truth and fearless in his use of it for the interest of mankind, seizing gladly the smallest fact from research and pressing it to the humblest service but always perceiving and enforcing the relations of both the fact and the service to the broadest interests of his states and of his fellow men. Thus all came to know him as richly wise, unswervingly true, and deeply patriotic and humanistic—a man whose thinking was as clear and whose motives were as unselfish as his service of them was forceful and effective.

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THE SCIENTIFIC WORK OF EUGENE WOLDEMAR HILGARD

EUGENE W. HILGARD accepted the position of assistant state geologist of Mississippi in 1855, at the age of twenty-two, but was well equipped for scientific investigations of any kind. He had spent his early boyhood days on a farm, giving his spare hours to the reading of standard works on chemistry and botany and in making collections of plants and insects; then in later years had completed his